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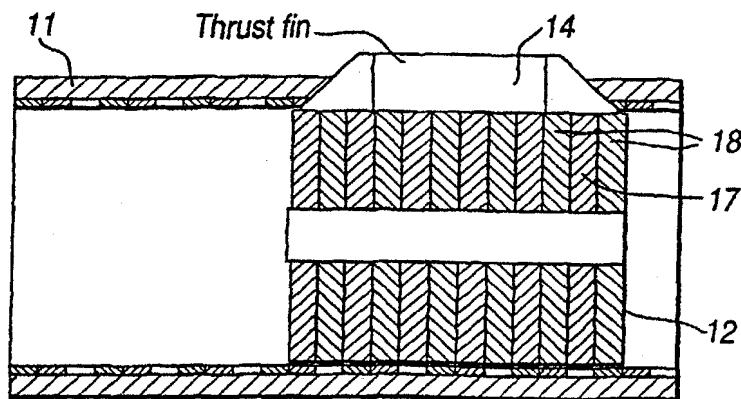
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(54) Title: ELECTROMAGNETIC RAMS



(57) Abstract: An electromagnetic ram in the form of a cylindrical magnetic assembly (11) arranged to receive a cooperating armature (12) for movement along the length of the cylinder. The armature (12) is provided with a transversely extending member (14) for transferring movement of the armature to the outside of the ram through an axially extending slot (15) in the cylinder (11).

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Electromagnetic Rams

The present invention relates to electromagnetic rams.

Such rams are known and have various constructions but principally they are all variations of piston and cylinder devices with the output being coaxial with the centre line of the ram. This causes difficulty when used in a confined space as it means that for a full stroke, one requires twice the length of the stroke to be available or for a part of the ram to be received in a recess in the mounting. This difficulty has resulted in electro magnetic rams being limited in their uses.

The present invention provides an electromagnetic ram where a member extending transverse to the axial direction is used to transfer movement of the armature to the outside of the ram through an axially extending slot.

In one embodiment, the ram is in the form of a stator provided with coils which cooperate with the magnetic field produced by a magnetic assembly on the armature to produce motion when energised. This in turn requires the coils to be wound in such a manner as to form a gap through which the transverse member may move.

Preferably, each coil is wound as a pair of coil sections in an approximation to a "figure of 8" and the coils are connected in sets of three so as to be capable of being energised by signals which are out of phase with each other eg by 120° to form a three phase drive.

In another embodiment, the ram is in the form of a stator provided with a permanent magnet in order to create a fixed field of alternate magnetic poles, and an armature having one or more coils wound on a former.

In this embodiment, the coils are conventional coils but it does require the provision of a special connector to provide power to the coils eg in the form of a flexible bend.

Advantageously, the permanent magnets of the stator are provided with pole pieces in the form of slotted discs and the pole pieces are preferably shaped in order to provide a desired shaping of the magnetic field.

In order that the present invention be more readily understood, an embodiment thereof will now be described with reference to the accompanying drawings, in which,

Fig 1 is a sectional side view of a first embodiment of an
5 electromagnetic ram according to the present invention;

Fig 2 is an end view of the ram shown in Fig 1;

Fig 3 is a diagrammatic representation of a coil formed by a pair of
coil sections; and

Fig 4 is a diagrammatic side view of another embodiment of the
10 present invention.

Referring to Fig. 1, an electromagnetic ram comprises a cylindrical stator 11 formed from a steel outer tube within which is mounted an armature 12 for movement along the length of the stator 11.

The armature 12 is shorter than the stator 11 and is provided with a
15 transversely extending member 14 which can take any convenient form but in this case is shown as a fin 14 which is elongate in the axial direction. The fin 14 is received in an axially extending slot 15 provided in the wall of the stator 11.

The armature 12 is constructed from one or more assemblies of a permanent magnet member 17 which is axially magnetised and sandwiched
20 between two pole pieces 18. If necessary, the pole pieces may be tapered towards their radial edges so as to reduce the field in the core and also the mass of the armature. It is also possible to insert a thin compliant disc between the pole pieces of adjacent magnetic assemblies. This will allow for manufacturing tolerances but also permits rams with long stators being formed which utilise an armature having
25 a number of magnetic assemblies.

Within the steel outer tube, the stator is provided with especially wound coils which leave a gap through which the member 14 may extend. As shown in Fig. 3, one way of achieving this is to wind each coil in the form of two coil portions in the form of a "Figure of 8". The coils are assembled in sets of three

(one pair of coil sections for each of three phases for each magnetic period). The current for each phase must alternate in direction hence the way in which the coils are wound without crossing the gap of the axially extending slot 15 in the stator. The magnetic assembly or assemblies project a strong magnetic field radially outwards through the coils of the stator; the magnetic flux returning via the outer steel tube that completes the assembly.

The interior of the stator 11 is preferably lined with a hard, slotted dielectric tube that serves as a bearing and seal surface. The armature 12 is provided with a bearing surface or surfaces e.g. in the form of piston rings which are arranged to slide along the hard dielectric tube.

Each assembly of a permanent magnet member 17 sandwiched between pole pieces 18 is preferably circular in axial cross-section. Because the armature 12 may be constructed from a number of assemblies it is possible to allow relative pivotal movement between each assembly or between groups of assemblies in any direction about the central axis. Thus, the armature, being carried on a series of bearing rings running on the stator lining tube which is made of a hard dielectric material, is able to follow irregularities, or even deliberate curvature, of the axis of the cylinder. This is a significant advantage if the ram is required to curve upwards or around an obstacle. It also provides tolerance to structural misalignments resulting from mechanical stress, temperature gradients or damage. While compliant discs between assemblies might be sufficient to provide the necessary amount of relative movement, other more complex coupling arrangements may be used depending upon the application. Further, the fin 14 may need to be articulated or the connection between the armature 12 and the fin 14 may need to be articulated.

With this basic electromagnetic construction, it is possible to form a number of different actuators. For example, if the stator is a closed cylinder eg sealed ends are provided to the tube shown in Fig 1, and the actuator is fitted with a circumferential seal and thus forms a piston, a rodless pneumatic actuator can be

formed when the interior is filled with a gas e.g. air which can be supplied from a fixed or variable pressure source. This in turn requires a sliding pressure seal 16 to be provided in the slot 15. Otherwise, the slot 15 need only have a protective seal against dirt and other contamination.

5 Also, the shape of the cylinder need not be constrained to be a circular cross section but may be elliptical so as to ensure that the fin 14 runs truly down the centre of the slot and can tolerate side forces.

 Further, the slotted stator may itself be curved and if curved to a uniform radius would allow the fin of the armature to move in an arc of a circle.
10 In this construction it may be essential to use compliant discs between each magnetic assembly in view of the fact that the armature slides against the lining tube provided on the stator. Consequently, if the fin 14 is replaced by or coupled to a radius arm, the arm could be connected to an orthogonal shaft so that the forces exerted on the armature exert a torque on that shaft. It will be understood
15 that by this means a high-torque may be directly produced with the minimum of moving parts. Further, if the arc is continued to a complete circle around the shaft in question, this allows the armature to be lengthened so as to fill the whole stator thus producing the maximum possible torque. The armature may then be caused to rotate continuously if required. This in turn forms a toroidal rotary motor which
20 could be used in the precise angular positioning of optical or other special equipment.

 Additionally, more than one ram can be utilised to effect movement of a single member. In other words, two or three rams could be mounted on either side of and connected to a common actuator member which in turn may have an
25 extension projecting out of a housing. The overall length of the system need be no longer than the length of one ram but the output will of course be a multiple of that of a single ram.

 The above embodiment is described as a ram having a permanent magnet armature and operating as a three phase synchronous machine. Other

constructions are possible such are one wh a the armature uses coils and the stator is formed with permanent magnets. Fig 4 shows diagrammatically one form of ram having such a construction. Here, the armature 12 is formed by a number of conventional coils 20 wound on a steel core 21, the coils being supplied with power by means of a trailing lead 22 of sufficient length to permit the armature to travel along the stator.

The stator 11 is formed by a number of permanent magnet section 24 poled to form alternating magnetic poles along the length of the stator 11. Each permanent magnet section 24 comprises a permanent magnet 24a and pole pieces 24b. It is preferred to shape the pole pieces 24b so that they appropriately shape the magnetic field. In this case, they taper uniformly towards the periphery of the permanent magnet of each section. This has the effect of decreasing the strong magnetic field around the outside of each section 24.

The sections 24 are each slotted and the slots are aligned so as to permit a transversely entering fin (not shown) attached to the armature 12 to be freely moved with the armature as in the first embodiment.

It is also possible to construct coils in order to form either the stator or armature as desired. In this technique when applied to a stator, the stator can be formed from a stock of planar iron rings separated from each other by cylindrical iron rings in order to form slots in a generally continuous iron cylinder. Each coil of copper is separately fitted into the slot between planar iron rings and appropriately energised to provide axially alternating magnetic poles. The iron structure could be replaced by a cast and/or metal component. Additionally, the stator may be designed to induce eddy currents in a passive armature so as to produce a low-cost machine suitable for opening doors or moving curtains.

One particular use of the ram as described is in an elevator where two or four slotted rams may be arranged against the inside walls of the elevator shaft, driving and guiding the cage silently, directly and precisely.

It will be appreciated that many uses of the actuator will require the

presence of a position detector in order to provide a feedback signal to a control unit in order to properly control the relative motion of the actuator by appropriate switching of the stator coils. This is not shown in the drawings but its location will depend to a large extent on the use to which the actuator is put and the actual construction of the actuator.

In the case of an elevator, the deadload of the cage and its payload is supported by gas within the stator. The exact value of this pressure is automatically adjusted by a small valve system and a small standby compressor. The gas pressure is controlled by a simple algorithm that integrates the value of the current supplied to the actuator in order to compensate for temperature changes, lenses, load changes and elevator parking arrangements. Since air is not consumed during elevator motion the compressor need not be of a large capacity.

With long stators such as are envisaged with elevators, the stator coils should be divided into relatively short sections. This permits only those sections of the stator coil assembly adjacent the armature to be energised and switched thus improving power efficiency.

CLAIMS:

1. An electromagnetic actuator comprising a first magnetic assembly, a second magnetic assembly, the polarity of one of said assemblies being changeable in response to an electrical control signal in order to cause relative movement between the first and second assemblies along an axis of relative movement, characterised in that one of the assemblies (12) is provided with a fin (14) extending transversely to said axis of relative movement and in that the other of the assemblies is provided with a slot (15) extending parallel to the axis of relative movement and arranged to receive the fin (14).
2. An actuator according to claim 1, wherein second assembly is in the form of a cylinder arranged to house the first assembly.
3. An actuator according to claim 2, wherein the second assembly comprises a plurality of permanent magnetic sections each having pole pieces (24b).
4. An actuator according to claim 3, wherein the pole pieces (24b) taper towards the outer periphery of the assembly.
5. An actuator according to claims 2,3 or 4, wherein the ends of the cylinder are sealed and the slot 15 is provided with a sliding seal (16) in order to provide clamping for the movement of the first assembly in the second assembly.
6. An actuator according to any one of claims 2 to 5, wherein the second assembly comprises a plurality of coils wound in order to create a channel to receive the fin of the first assembly.

7. An actuator according to claim 6, wherein the coils are wound in pairs in a figure of eight.
8. An assembly according to any one of the preceding claims.

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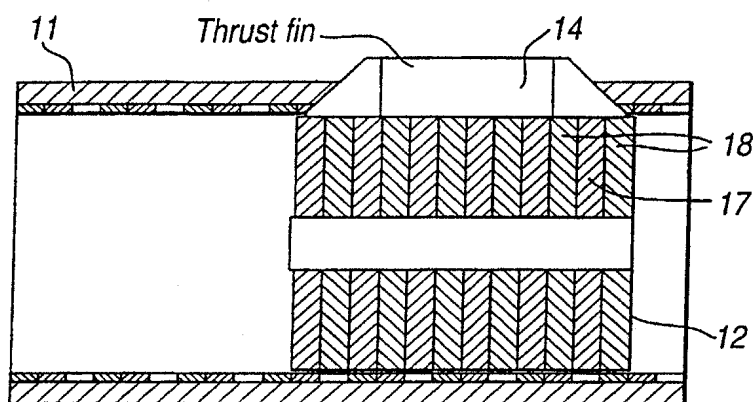


Fig. 1

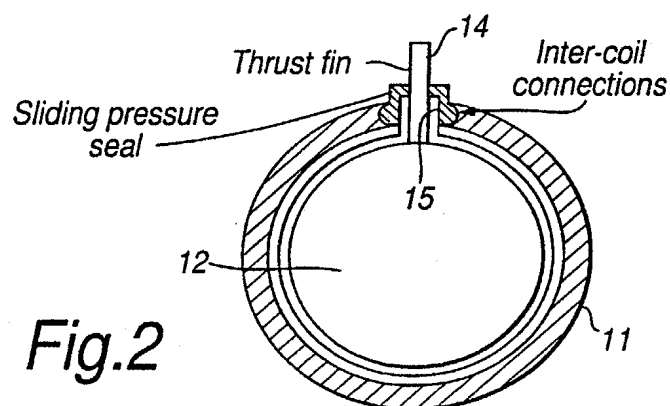


Fig. 2

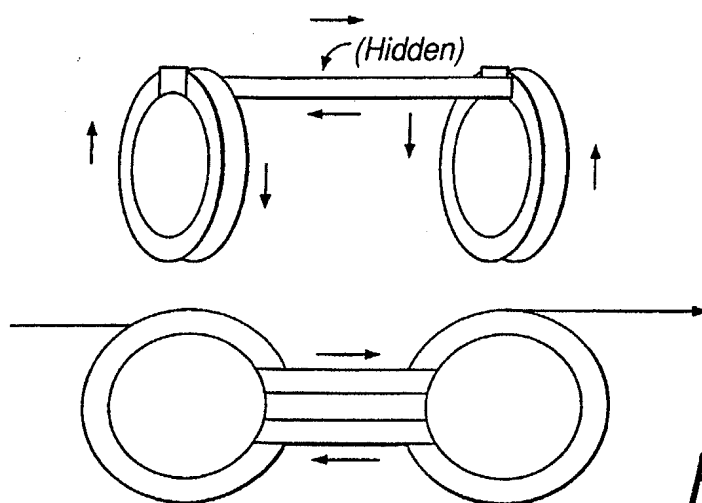


Fig. 3

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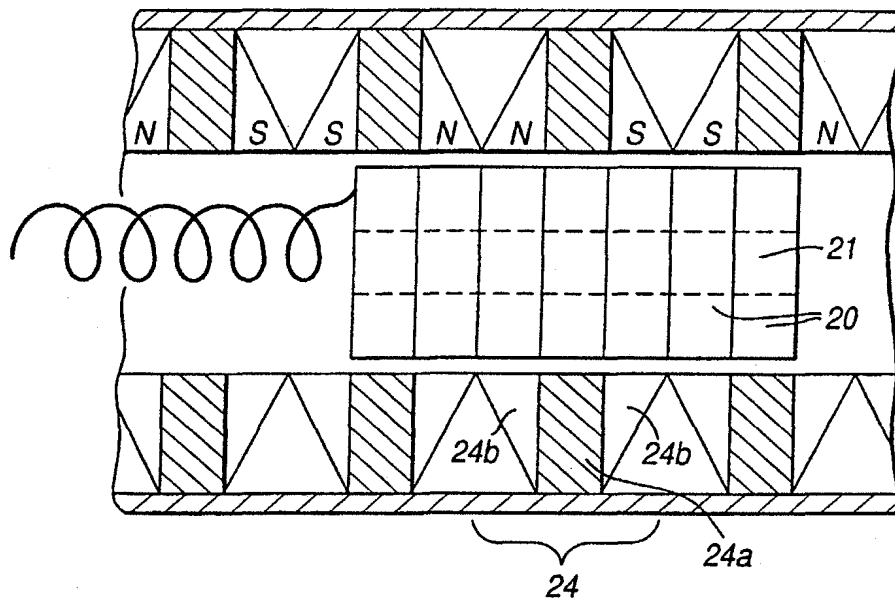


Fig.4

INTERNATIONAL SEARCH REPORT

International Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H01F7/16 H01F7/06 H02K41/03

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H01F H02K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EP0-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 245 917 A (MOSCIATTI ROGER ET AL) 20 January 1981 (1981-01-20)	1,2
A	abstract; figure 2 column 2, line 56-68	3
A	US 4 439 700 A (MENZEL KLAUS ET AL) 27 March 1984 (1984-03-27) column 2, line 21-47; figure 2 column 3, line 14-26	1
A	EP 0 459 889 A (SONY CORP) 4 December 1991 (1991-12-04) figure 19	1

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents:

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- "E" earlier document but published on or after the international filing date
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- "P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

17 October 2000

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
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Patent document cited in search report		Publication date	Patent family member(s)	Publication date
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US 4439700	A	27-03-1984	DE 3267952 D	30-01-1986
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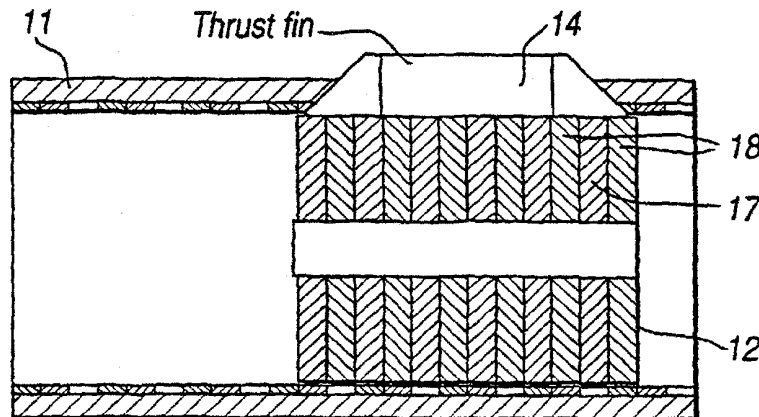
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- (71) Applicant (for all designated States except US): KINETIC DEVELOPMENTS LIMITED [GB/GB]; MWB Business Centre, 23 Hinton Road, Bournemouth, Dorset B41 2EP (GB).
- (72) Inventor; and
- (75) Inventor/Applicant (for US only): DENNE, Phillip, Raymond, Michael [GB/GB]; 7 Lyndon Gate, Chine Crescent Road, Bournemouth BH2 5LW (GB).
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(57) Abstract: An electromagnetic ram in the form of a cylindrical magnetic assembly (11) arranged to receive a cooperating armature (12) for movement along the length of the cylinder. The armature (12) is provided with a transversely extending member (14) for transferring movement of the armature to the outside of the ram through an axially extending slot (15) in the cylinder (11).

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Electromagnetic Rams

The present invention relates to electromagnetic rams.

Such rams are known and have various constructions but principally they are all variations of piston and cylinder devices with the output being coaxial with the centre line of the ram. This causes difficulty when used in a confined space as it means that for a full stroke, one requires twice the length of the stroke to be available or for a part of the ram to be received in a recess in the mounting. This difficulty has resulted in electro magnetic rams being limited in their uses.

The present invention provides an electromagnetic ram where a member extending transverse to the axial direction is used to transfer movement of the armature to the outside of the ram through an axially extending slot.

In one embodiment, the ram is in the form of a stator provided with coils which cooperate with the magnetic field produced by a magnetic assembly on the armature to produce motion when energised. This in turn requires the coils to be wound in such a manner as to form a gap through which the transverse member may move.

Preferably, each coil is wound as a pair of coil sections in an approximation to a "figure of 8" and the coils are connected in sets of three so as to be capable of being energised by signals which are out of phase with each other eg by 120° to form a three phase drive.

In another embodiment, the ram is in the form of a stator provided with a permanent magnet in order to create a fixed field of alternate magnetic poles, and an armature having one or more coils wound on a former.

In this embodiment, the coils are conventional coils but it does require the provision of a special connector to provide power to the coils eg in the form of a flexible bend.

Advantageously, the permanent magnets of the stator are provided with pole pieces in the form of slotted discs and the pole pieces are preferably shaped in order to provide a desired shaping of the magnetic field.

In order that the present invention be more readily understood, an embodiment thereof will now be described with reference to the accompanying drawings, in which,

Fig 1 is a sectional side view of a first embodiment of an electromagnetic ram according to the present invention;

Fig 2 is an end view of the ram shown in Fig 1;

Fig 3 is a diagrammatic representation of a coil formed by a pair of coil sections; and

Fig 4 is a diagrammatic side view of another embodiment of the present invention.

Referring to Fig. 1, an electromagnetic ram comprises a cylindrical stator 11 formed from a steel outer tube within which is mounted an armature 12 for movement along the length of the stator 11.

The armature 12 is shorter than the stator 11 and is provided with a transversely extending member 14 which can take any convenient form but in this case is shown as a fin 14 which is elongate in the axial direction. The fin 14 is received in an axially extending slot 15 provided in the wall of the stator 11.

The armature 12 is constructed from one or more assemblies of a permanent magnet member 17 which is axially magnetised and sandwiched between two pole pieces 18. If necessary, the pole pieces may be tapered towards their radial edges so as to reduce the field in the core and also the mass of the armature. It is also possible to insert a thin compliant disc between the pole pieces of adjacent magnetic assemblies. This will allow for manufacturing tolerances but also permits rams with long stators being formed which utilise an armature having a number of magnetic assemblies.

Within the steel outer tube, the stator is provided with especially wound coils which leave a gap through which the member 14 may extend. As shown in Fig. 3, one way of achieving this is to wind each coil in the form of two coil portions in the form of a "Figure of 8". The coils are assembled in sets of three

(one pair of coil sections for each of three phases for each magnetic period). The current for each phase must alternate in direction hence the way in which the coils are wound without crossing the gap of the axially extending slot 15 in the stator. The magnetic assembly or assemblies project a strong magnetic field radially outwards through the coils of the stator; the magnetic flux returning via the outer steel tube that completes the assembly.

The interior of the stator 11 is preferably lined with a hard, slotted dielectric tube that serves as a bearing and seal surface. The armature 12 is provided with a bearing surface or surfaces e.g. in the form of piston rings which are arranged to slide along the hard dielectric tube.

Each assembly of a permanent magnet member 17 sandwiched between pole pieces 18 is preferably circular in axial cross-section. Because the armature 12 may be constructed from a number of assemblies it is possible to allow relative pivotal movement between each assembly or between groups of assemblies in any direction about the central axis. Thus, the armature, being carried on a series of bearing rings running on the stator lining tube which is made of a hard dielectric material, is able to follow irregularities, or even deliberate curvature, of the axis of the cylinder. This is a significant advantage if the ram is required to curve upwards or around an obstacle. It also provides tolerance to structural misalignments resulting from mechanical stress, temperature gradients or damage. While compliant discs between assemblies might be sufficient to provide the necessary amount of relative movement, other more complex coupling arrangements may be used depending upon the application. Further, the fin 14 may need to be articulated or the connection between the armature 12 and the fin 14 may need to be articulated.

With this basic electromagnetic construction, it is possible to form a number of different actuators. For example, if the stator is a closed cylinder eg sealed ends are provided to the tube shown in Fig 1, and the actuator is fitted with a circumferential seal and thus forms a piston, a rodless pneumatic actuator can be

formed when the interior is filled with a gas e.g. air which can be supplied from a fixed or variable pressure source. This in turn requires a sliding pressure seal 16 to be provided in the slot 15. Otherwise, the slot 15 need only have a protective seal against dirt and other contamination.

5 Also, the shape of the cylinder need not be constrained to be a circular cross section but may be elliptical so as to ensure that the fin 14 runs truly down the centre of the slot and can tolerate side forces.

 Further, the slotted stator may itself be curved and if curved to a uniform radius would allow the fin of the armature to move in an arc of a circle.
10 In this construction it may be essential to use compliant discs between each magnetic assembly in view of the fact that the armature slides against the lining tube provided on the stator. Consequently, if the fin 14 is replaced by or coupled to a radius arm, the arm could be connected to an orthogonal shaft so that the forces exerted on the armature exert a torque on that shaft. It will be understood
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It will be appreciated that many uses of the actuator will require the

presence of a position detector in order to provide a feedback signal to a control unit in order to properly control the relative motion of the actuator by appropriate switching of the stator coils. This is not shown in the drawings but its location will depend to a large extent on the use to which the actuator is put and the actual construction of the actuator.

In the case of an elevator, the deadload of the cage and its payload is supported by gas within the stator. The exact value of this pressure is automatically adjusted by a small valve system and a small standby compressor. The gas pressure is controlled by a simple algorithm that integrates the value of the current supplied to the actuator in order to compensate for temperature changes, lenses, load changes and elevator parking arrangements. Since air is not consumed during elevator motion the compressor need not be of a large capacity.

With long stators such as are envisaged with elevators, the stator coils should be divided into relatively short sections. This permits only those sections of the stator coil assembly adjacent the armature to be energised and switched thus improving power efficiency.

CLAIMS:

1. An electromagnetic actuator comprising a first magnetic assembly, a second magnetic assembly, the polarity of one of said assemblies being changeable in response to an electrical control signal in order to cause relative movement between the first and second assemblies along an axis of relative movement, characterised in that one of the assemblies (12) is provided with a fin (14) extending transversely to said axis of relative movement and in that the other of the assemblies is provided with a slot (15) extending parallel to the axis of relative movement and arranged to receive the fin (14).
2. An actuator according to claim 1, wherein second assembly is in the form of a cylinder arranged to house the first assembly.
3. An actuator according to claim 2, wherein the second assembly comprises a plurality of permanent magnetic sections each having pole pieces (24b).
4. An actuator according to claim 3, wherein the pole pieces (24b) taper towards the outer periphery of the assembly.
5. An actuator according to claims 2,3 or 4, wherein the ends of the cylinder are sealed and the slot 15 is provided with a sliding seal (16) in order to provide clamping for the movement of the first assembly in the second assembly.
6. An actuator according to any one of claims 2 to 5, wherein the second assembly comprises a plurality of coils wound in order to create a channel to receive the fin of the first assembly.

7. An actuator according to claim 6, wherein the coils are wound in pairs in a figure of eight.
8. An assembly according to any one of the preceding claims.

1/2

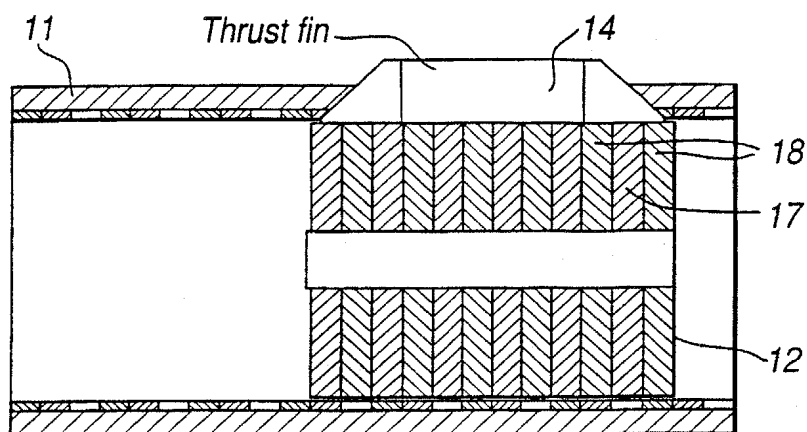


Fig. 1

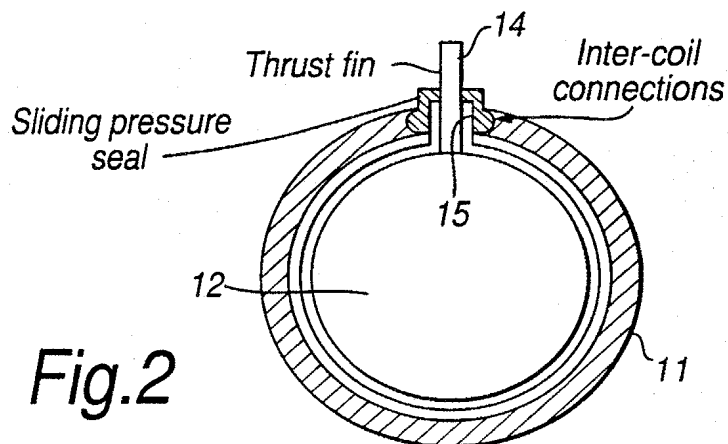


Fig. 2

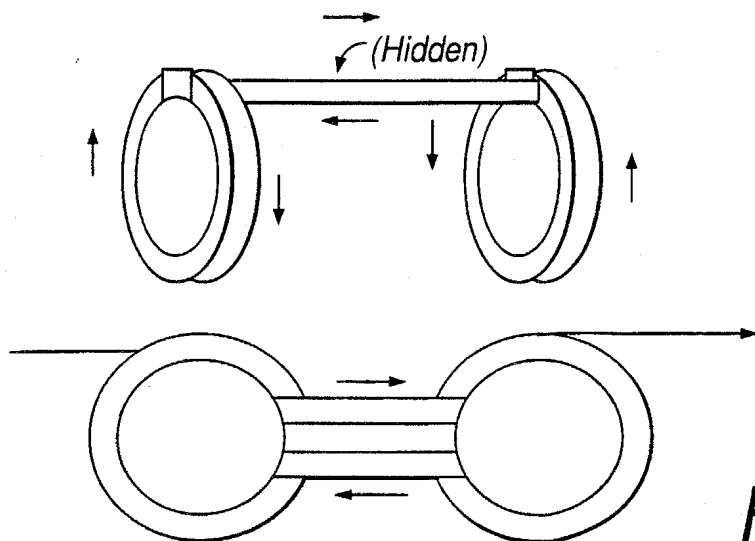


Fig. 3

2/2

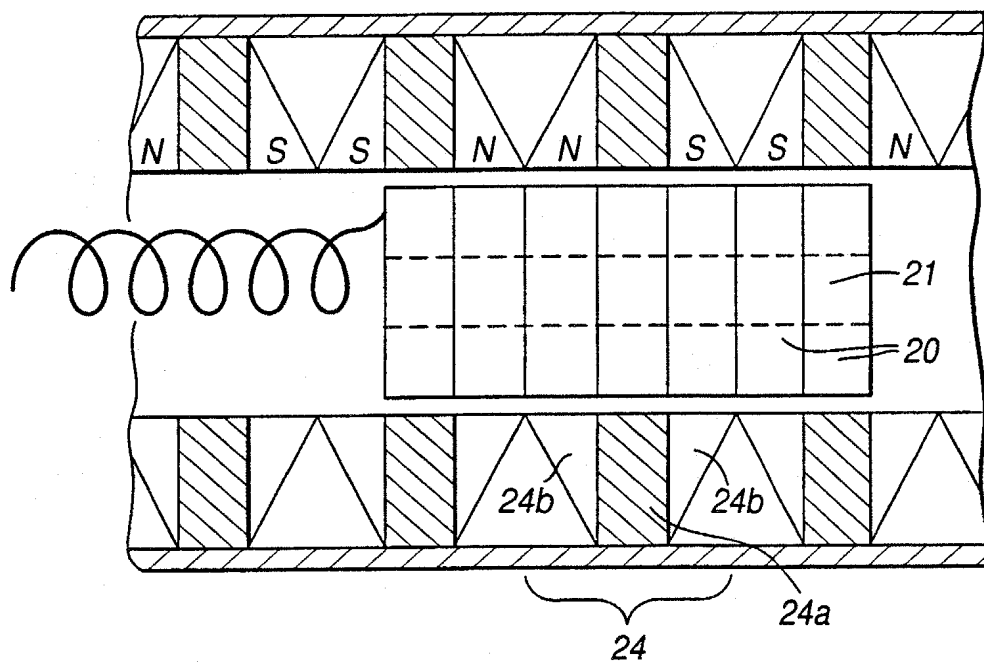


Fig.4

INTERNATIONAL SEARCH REPORT

Inte application No

PCT/GB 00/02563

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 H01F7/16 H01F7/06 H02K41/03

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H01F H02K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 245 917 A (MOSCIATTI ROGER ET AL) 20 January 1981 (1981-01-20)	1,2
A	abstract; figure 2 column 2, line 56-68	3
A	US 4 439 700 A (MENZEL KLAUS ET AL) 27 March 1984 (1984-03-27) column 2, line 21-47; figure 2 column 3, line 14-26	1
A	EP 0 459 889 A (SONY CORP) 4 December 1991 (1991-12-04) figure 19	1

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

17 October 2000

Date of mailing of the international search report

24/10/2000

Name and mailing address of the ISA

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Fax: (+31-70) 340-3016

Authorized officer

Durville, G

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/GB 00/02563

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 4245917	A	20-01-1981	NONE	
US 4439700	A	27-03-1984	DE 3267952 D EP 0060969 A JP 1642088 C JP 3000761 B JP 57169214 A	30-01-1986 29-09-1982 18-02-1992 08-01-1991 18-10-1982
EP 0459889	A	04-12-1991	JP 2751567 B JP 4030506 A DE 69103217 D DE 69103217 T HK 1007644 A KR 201446 B US 5182481 A	18-05-1998 03-02-1992 08-09-1994 02-02-1995 16-04-1999 15-06-1999 26-01-1993

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference ABC/19647	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/GB00/02563	International filing date (day/month/year) 04/07/2000	Priority date (day/month/year) 05/07/1999
International Patent Classification (IPC) or national classification and IPC H01F7/16		
Applicant KINETIC DEVELOPMENTS LIMITED et al.		


1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 5 sheets, including this cover sheet.

☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

 These annexes consist of a total of 4 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☒ Certain defects in the international application
- VIII ☒ Certain observations on the international application

Date of submission of the demand 05/02/2001	Date of completion of this report 23.11.2001
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Gols, J Telephone No. +49 89 2399 2616



**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/GB00/02563

I. Basis of the report

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

Description, pages:

3-6 as originally filed

1,2 as received on 01/10/2001 with letter of 01/10/2001

Claims, No.:

1-7 as received on 01/10/2001 with letter of 01/10/2001

Drawings, sheets:

1/2,2/2 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/GB00/02563

- ☐ the description, pages:
☐ the claims, Nos.:
☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-7
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-7
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-7
	No:	Claims	

2. Citations and explanations
see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:
see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:
see separate sheet

V

1. Claim 1:

Technical field:

Prior art: X-document D1: US-A-4 245 917 discloses an electromagnetic actuator according to the preamble of claim 1. The remaining A-documents do not provide further relevant information.

Problem: To control the relative movement of first and second magnetic assemblies comprised in the electromagnetic actuator. The polarity of on one the assemblies being changeable in response to an electric control signal.

Solution: Claim 1 is characterised in that the other assembly comprises a plurality of magnetic elements in order to create axially alternating magnetic fields.

Inventive step: In D1 one of the assemblies comprises a plurality of magnetic elements in order to create axially steady magnetic fields, since the polarities of the magnetic elements in that assembly remains unchanged in the axial direction. In the actuator as claimed, due to the creation of the axially alternating fields, the propulsion forces present in the actuator can be controlled by the creation of these alternating magnetic fields, whereby a controlled relative (linear or reciprocal) movement of the assemblies is arrived at. The plurality of magnetic elements creating axially alternating magnetic fields is not taught in the available prior art. Consequently claim 1 meets the requirements of Articles 33(2) - (4) EPC.

2. Claims: 2 - 7

These dependent claims are related to embodiments of the invention as set out in the independent claim and as such meet the requirements of Article 33(2) - (4) PCT.

VII

1. The embodiment of the invention described on page 2, lines 14 - 16 (mentioning that the fin is an option for some extending member) does not fall within the scope of claim 1 (only claiming the fin and not an extending member). This inconsistency

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/GB00/02563

between the claims and the description leads to doubt concerning the matter for which protection is sought, thereby rendering the claims unclear (Article 6 PCT).

2. To meet the requirements of Rule 5.1(a)(ii) PCT, the document D1 should have been identified in the description and the relevant background art disclosed therein should have been briefly discussed.
3. The description is not in conformity with the claims as required by Rule 5.1(a)(iii) PCT.

VIII

1. in claim 1 the feature "axially" should have been explained in order to clarify to which axis the feature "axially" refers to. Furthermore, it should have been clarified which one of the first and second assemblies is allowed to move in response to the electrical control signal.
2. Not all the features of the claims are provided with reference signs placed in parentheses (Rule 6.2(b) PCT).

Electromagnetic Rams

The present invention relates to electromagnetic rams.

Such rams are known and have various constructions but principally they are all variations of piston and cylinder devices with the output being coaxial with the centre line of the ram. This causes difficulty when used in a confined space as it means that for a full stroke, one requires twice the length of the stroke to be available or for a part of the ram to be received in a recess in the mounting. This difficulty has resulted in electro magnetic rams being limited in their uses.

The present invention provides an electromagnetic ram where a member extending transverse to the axial direction is used to transfer movement of the armature to the outside of the ram through an axially extending slot.

In one embodiment, the ram is in the form of a stator provided with coils which cooperate with the magnetic field produced by a magnetic assembly on the armature to produce motion when energised. This in turn requires the coils to be wound in such a manner as to form a gap through which the transverse member may move.

Preferably, each coil is wound as a pair of coil sections in an approximation to a "figure of 8" and the coils are connected in sets of three so as to be capable of being energised by signals which are out of phase with each other eg by 120° to form a three phase drive.

In another embodiment, the ram is in the form of a stator provided with a permanent magnet in order to create a fixed field of alternate magnetic poles, and an armature having one or more coils wound on a former.

In this embodiment, the coils are conventional coils but it does require the provision of a special connector to provide power to the coils eg in the form of a flexible bend.

Advantageously, the permanent magnets of the stator are provided with pole pieces in the form of slotted discs and the pole pieces are preferably shaped in order to provide a desired shaping of the magnetic field.

In order that the present invention be more readily understood, an embodiment thereof will now be described with reference to the accompanying drawings, in which,

Fig 1 is a sectional side view of a first embodiment of an
5 electromagnetic ram according to the present invention;

Fig 2 is an end view of the ram shown in Fig 1;

Fig 3 is a diagrammatic representation of a coil formed by a pair of
coil sections; and

Fig 4 is a diagrammatic side view of another embodiment of the
10 present invention.

Referring to Fig. 1, an electromagnetic ram comprises a cylindrical stator 11 formed from a steel outer tube within which is mounted an armature 12 for movement along the length of the stator 11.

The armature 12 is shorter than the stator 11 and is provided with a
15 transversely extending member 14 which can take any convenient form but in this case is shown as a fin 14 which is elongate in the axial direction. The fin 14 is received in an axially extending slot 15 provided in the wall of the stator 11.

The armature 12 is constructed from one or more assemblies of a
permanent magnet member 17 which is axially magnetised and sandwiched
20 between two pole pieces 18. If necessary, the pole pieces may be tapered towards their radial edges so as to reduce the field in the core and also the mass of the armature. It is also possible to insert a thin compliant disc between the pole pieces of adjacent magnetic assemblies. This will allow for manufacturing tolerances but also permits rams with long stators being formed which utilise an armature having
25 a number of magnetic assemblies.

Within the steel outer tube, the stator is provided with especially wound coils which leave a gap through which the member 14 may extend. As shown in Fig. 3, one way of achieving this is to wind each coil in the form of two coil portions in the form of a "Figure of 8". The coils are assembled in sets of three

CLAIMS:

1. An electromagnetic actuator comprising a first magnetic assembly, a second magnetic assembly, the polarity of one of said assemblies being changeable in response to an electrical control signal in order to cause relative movement between the first and second assemblies along an axis of relative movement, characterised in that one of the assemblies (12) is provided with a fin (14) extending transversely to said axis of relative movement and in that the other of the assemblies is provided with a slot (15) extending parallel to the axis of relative movement and arranged to receive the fin (14).
2. An actuator according to claim 1, wherein second assembly is in the form of a cylinder arranged to house the first assembly.
3. An actuator according to claim 2, wherein the second assembly comprises a plurality of permanent magnetic sections each having pole pieces (24b).
4. An actuator according to claim 3, wherein the pole pieces (24b) taper towards the outer periphery of the assembly.
5. An actuator according to claims 2,3 or 4, wherein the ends of the cylinder are sealed and the slot 15 is provided with a sliding seal (16) in order to provide clamping for the movement of the first assembly in the second assembly.
6. An actuator according to any one of claims 2 to 5, wherein the second assembly comprises a plurality of coils wound in order to create a channel to receive the fin of the first assembly.

7. An actuator according to claim 6, wherein the coils are wound in pairs in a figure of eight.

8. An assembly according to any one of the preceding claims..

REC'D 27 NOV 2001

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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

14

Applicant's or agent's file reference ABC/19647	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/GB00/02563	International filing date (day/month/year) 04/07/2000	Priority date (day/month/year) 05/07/1999
International Patent Classification (IPC) or national classification and IPC H01F7/16		
Applicant KINETIC DEVELOPMENTS LIMITED et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.



2. This REPORT consists of a total of 5 sheets, including this cover sheet.

- ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 4 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☒ Certain defects in the international application
- VIII ☒ Certain observations on the international application

Date of submission of the demand 05/02/2001	Date of completion of this report 23.11.2001
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Gols, J Telephone No. +49 89 2399 2616 

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/GB00/02563

I. Basis of the report

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

Description, pages:

3-6 as originally filed

1,2 as received on 01/10/2001 with letter of 01/10/2001

Claims, No.:

1-7 as received on 01/10/2001 with letter of 01/10/2001

Drawings, sheets:

1/2,2/2 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
 - ☐ the language of publication of the international application (under Rule 48.3(b)).
 - ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).
3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:
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 - ☐ furnished subsequently to this Authority in computer readable form.
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**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/GB00/02563

- ☐ the description, pages:
☐ the claims, Nos.:
☐ the drawings, sheets:

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6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-7
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-7
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-7
	No:	Claims	

2. Citations and explanations
see separate sheet

VII. Certain defects in the international application

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see separate sheet

VIII. Certain observations on the international application

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V

1. Claim 1:

Technical field:

Prior art: X-document D1: US-A-4 245 917 discloses an electromagnetic actuator according to the preamble of claim 1. The remaining A-documents do not provide further relevant information.

Problem: To control the relative movement of first and second magnetic assemblies comprised in the electromagnetic actuator. The polarity of on one the assemblies being changeable in response to an electric control signal.

Solution: Claim 1 is characterised in that the other assembly comprises a plurality of magnetic elements in order to create axially alternating magnetic fields.

Inventive step: In D1 one of the assemblies comprises a plurality of magnetic elements in order to create axially steady magnetic fields, since the polarities of the magnetic elements in that assembly remains unchanged in the axial direction. In the actuator as claimed, due to the creation of the axially alternating fields, the propulsion forces present in the actuator can be controlled by the creation of these alternating magnetic fields, whereby a controlled relative (linear or reciprocal) movement of the assemblies is arrived at. The plurality of magnetic elements creating axially alternating magnetic fields is not taught in the available prior art. Consequently claim 1 meets the requirements of Articles 33(2) - (4) EPC.

2. Claims: 2 - 7

These dependent claims are related to embodiments of the invention as set out in the independent claim and as such meet the requirements of Article 33(2) - (4) PCT.

VII

1. The embodiment of the invention described on page 2, lines 14 - 16 (mentioning that the fin is an option for some extending member) does not fall within the scope of claim 1 (only claiming the fin and not an extending member). This inconsistency

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/GB00/02563

between the claims and the description leads to doubt concerning the matter for which protection is sought, thereby rendering the claims unclear (Article 6 PCT).

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VIII

1. in claim 1 the feature "axially" should have been explained in order to clarify to which axis the feature "axially" refers to. Furthermore, it should have been clarified which one of the first and second assemblies is allowed to move in response to the electrical control signal.
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Electromagnetic Rams

The present invention relates to electromagnetic rams.

Such rams are known and have various constructions but principally they are all variations of piston and cylinder devices with the output being coaxial
5 with the centre line of the ram. This causes difficulty when used in a confined space as it means that for a full stroke, one requires twice the length of the stroke to be available or for a part of the ram to be received in a recess in the mounting. This difficulty has resulted in electro magnetic rams being limited in their uses.

The present invention provides an electromagnetic ram where a
10 member extending transverse to the axial direction is used to transfer movement of the armature to the outside of the ram through an axially extending slot.

In one embodiment, the ram is in the form of a stator provided with coils which cooperate with the magnetic field produced by a magnetic assembly on the armature to produce motion when energised. This in turn requires the coils to
15 be wound in such a manner as to form a gap through which the transverse member may move.

Preferably, each coil is wound as a pair of coil sections in an approximation to a "figure of 8" and the coils are connected in sets of three so as to be capable of being energised by signals which are out of phase with each other,
20 for example by 120° , to form a three phase drive.

In another embodiment, the ram is in the form of a stator provided with a permanent magnet in order to create a fixed field of alternate magnetic poles, and an armature having one or more coils wound on a former.

In this embodiment, the coils are conventional coils but it does
25 require the provision of a special connector to provide power to the coils eg in the form of a flexible bend.

Advantageously, the permanent magnets of the stator are provided with pole pieces in the form of slotted discs and the pole pieces are preferably shaped in order to provide a desired shaping of the magnetic field.

In order that the present invention be more readily understood, an embodiment thereof will now be described with reference to the accompanying drawings, in which,

Fig 1 is a sectional side view of a first embodiment of an
5 electromagnetic ram according to the present invention;

Fig 2 is an end view of the ram shown in Fig 1;

Fig 3 is a diagrammatic representation of a coil formed by a pair of
coil sections; and

Fig 4 is a diagrammatic side view of another embodiment of the
10 present invention.

Referring to Fig. 1, an electromagnetic ram comprises a cylindrical stator 11 formed from a steel outer tube within which is mounted an armature 12 for movement along the length of the stator 11.

The armature 12 is shorter than the stator 11 and is provided with a
15 transversely directed member 14 which can take any convenient form but in this case is shown as a fin 14 which is elongate in the axial direction. The fin 14 is received in an axially extending slot 15 provided in the wall of the stator 11.

The armature 12 is constructed from one or more assemblies of a
permanent magnet member 17 which is axially magnetised and sandwiched
20 between two pole pieces 18. If necessary, the pole pieces may be tapered towards their radial edges so as to reduce the field in the core and also the mass of the armature. It is also possible to insert a thin compliant disc between the pole pieces of adjacent magnetic assemblies. This will allow for manufacturing tolerances but also permits rams with long stators being formed which utilise an armature having
25 a number of magnetic assemblies.

Within the steel outer tube, the stator is provided with especially wound coils which leave a gap through which the member 14 may extend. As shown in Fig. 3, one way of achieving this is to wind each coil in the form of two coil portions in the form of a "Figure of 8". The coils are assembled in sets of three

CLAIMS:

1. An electromagnetic actuator comprising a first magnetic assembly, a second magnetic assembly, the polarity of one of said assemblies being changeable
5 in response to an electrical control signal in order to cause relative movement between the first and second assemblies along an axis of relative movement, one of the assemblies (12) being provided with a fin (14) projecting transversely to said axis of relative movement and the other of the assemblies being provided with a slot (15) extending parallel to the axis of relative movement and arranged to
10 receive the fin (14), characterised in that the said other assembly comprises a plurality of magnetic elements in order to create axially alternating magnetic fields.
2. An actuator according to claim 1, wherein said other assembly is in
15 the form of a cylinder arranged to house the first assembly.
3. An actuator according to claim 2, wherein the second assembly comprises a plurality of permanent magnetic sections each having pole pieces (24b).
20
4. An actuator according to claim 3, wherein the pole pieces (24b) taper towards the outer periphery of the assembly.
5. An actuator according to claims 2,3 or 4, wherein the ends of the
25 cylinder are sealed and the slot 15 is provided with a sliding seal (16) in order to provide clamping for the movement of the first assembly in the second assembly.
6. An actuator according to any one of claims 2 to 5, wherein the said other assembly comprises a plurality of coils wound in order to create a channel to

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receive the fin of the first assembly.

7. An actuator according to claim 6, wherein the coils are wound in pairs in a figure of eight.

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PATENT COOPERATION TREATY

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

Commissioner
US Department of Commerce
United States Patent and Trademark
Office, PCT
2011 South Clark Place Room
CP2/5C24
Arlington, VA 22202
ETATS-UNIS D'AMERIQUE
in its capacity as elected Office

Date of mailing (day/month/year) 05 April 2001 (05.04.01)	
International application No. PCT/GB00/02563	Applicant's or agent's file reference ABC/19647
International filing date (day/month/year) 04 July 2000 (04.07.00)	Priority date (day/month/year) 05 July 1999 (05.07.99)
Applicant DENNE, Phillip, Raymond, Michael	

1. The designated Office is hereby notified of its election made:

☒ in the demand filed with the International Preliminary Examining Authority on:

05 February 2001 (05.02.01)

☐ in a notice effecting later election filed with the International Bureau on:

2. The election ☒ was
☐ was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No.: (41-22) 740.14.35	Authorized officer Pascal Piriou Telephone No.: (41-22) 338.83.38
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PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference ABC/19647	FOR FURTHER ACTION <small>see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.</small>	
International application No. PCT/GB 00/ 02563	International filing date (day/month/year) 04/07/2000	(Earliest) Priority Date (day/month/year) 05/07/1999
Applicant KINETIC DEVELOPMENTS LIMITED et al.		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 2 sheets.

☒ It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report

a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

☐ the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. ☐ **Certain claims were found unsearchable** (See Box I).

3. ☐ **Unity of Invention is lacking** (see Box II).

4. With regard to the **title**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No.

☒ as suggested by the applicant.

☐ because the applicant failed to suggest a figure.

☐ because this figure better characterizes the invention.

1
☐ None of the figures.

INTERNATIONAL SEARCH REPORT

International Application No

PC 00/02563

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 H01F7/16 H01F7/06 H02K41/03

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H01F H02K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 245 917 A (MOSCIATTI ROGER ET AL) 20 January 1981 (1981-01-20)	1,2
A	abstract; figure 2 column 2, line 56-68	3
A	US 4 439 700 A (MENZEL KLAUS ET AL) 27 March 1984 (1984-03-27) column 2, line 21-47; figure 2 column 3, line 14-26	1
A	EP 0 459 889 A (SONY CORP) 4 December 1991 (1991-12-04) figure 19	1

☐ Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

17 October 2000

Date of mailing of the international search report

24/10/2000

Name and mailing address of the ISA

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Authorized officer

Durville, G

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PC 00/02563

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 4245917	A	20-01-1981	NONE	
US 4439700	A	27-03-1984	DE 3267952 D	30-01-1986
			EP 0060969 A	29-09-1982
			JP 1642088 C	18-02-1992
			JP 3000761 B	08-01-1991
			JP 57169214 A	18-10-1982
EP 0459889	A	04-12-1991	JP 2751567 B	18-05-1998
			JP 4030506 A	03-02-1992
			DE 69103217 D	08-09-1994
			DE 69103217 T	02-02-1995
			HK 1007644 A	16-04-1999
			KR 201446 B	15-06-1999
			US 5182481 A	26-01-1993